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REPORT OF ALASKA EXPLORATORY FISHING EXPEDITION, FALL OF 1948, TO NORTHERN BERING SEA

By J. G. Ellson*, Boris Knake* and John Dassow**

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Introduction

On July 1, 1948 funds were authorized by Congress for the acquisition of an exploratory fishing vessel and for its operation in Alaskan coastal waters. In addition to exploratory fishing, engineering studies were to be carried out to develop more efficient methods of gear operation.

Although it has been suspected for many years that a considerable resource of food fish exists in Alaskan waters, particularly in the Bering Sea and in the offshore waters of the Pacific Ocean, the Service has been able to finance only limited and sporadic fishery surveys in this area. In order to make effective progress, a program of exploration must be on a continuous and methodical basis, and must suffer as little interruption of work as possible. Full advantage must be taken of all available fishing time in the areas to be worked, which, for the Bering Sea and offshore waters of the Pacific means the months of June, July, and August, since this is the period of most favorable weather. However, such a schedule was not possible for the subject survey because of the unavailability of funds until July 1.

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* Fishery Engineer, Fish and Wildlife Service Technological Laboratory, Seattle and Boston, respectively.
** Chemist, Fish and Wildlife Service Technological Laboratory, Seattle.

The fishery resources of most of the vast oceanic areas off the Alaskan coast are entirely unknown. Such potentially rich grounds as the offshore area from Dixon Entrance to the Aleutian Islands and beyond remain virtually unexplored while the entire Bering Sea area bounded by the Alaskan coastline and extending seaward from Cape Newenham through the Pribilof Islands, the Bering Straits and into the Arctic Ocean is practically unknown to American fishermen. Accurate knowledge of the true fishery resources of Alaska will only be revealed by extensive and continuing exploratory investigations. These sustained investigations must necessarily be sufficiently comprehensive to determine seasonal occurrence and abundance as well as the nature and type of fishing grounds and the efficiency of various fishing techniques. So long as pay loads can be made in known areas, private enterprise cannot be expected to seek new and unprospected areas. Economic considerations dictate otherwise. If the present commercial fishing effort could be more widely diffused, it would be of aid to conservation of our local resources by relieving fishing strain on populations now heavily exploited. The exploratory work should, therefore, not only make available new sources of natural wealth, but also assist in the conservation of the existing known fishery resources.

Historical Background

During 1940 and 1941 the Fish and Wildlife Service conducted an exploratory investigation[1] of the king crab fishery off the coast of Alaska. This survey was made possible by a special appropriation which permitted the chartering of a cannery vessel and three fishing vessels. Because of the limited duration of the availability of funds and weather restrictions, the investigation was largely confined to the inshore waters of central and western Alaska and Bristol Bay. Although inadequate for the tremendous area involved, the expedition not only disclosed sources of crabs, but also indicated that in some of the areas visited, the capture of large quantities of bottom fish could be expected. These results encouraged several commercial enterprises to enter this fishery.

Whenever the opportunity has presented itself, the Service has placed observers aboard fishing vessels working in Alaskan areas. This was done in the case of the trawlers Alaska and Deep Sea; and of the factory ship, Pacific Explorer. Considerable information has been gained in this manner.

In September, 1945, the Service issued a preliminary report of the fishery possibilities of the Nome area.[2] The report was based on interviews with various people residing in the area, and was intended to consolidate their knowledge concerning the fishing potentialities of the area. In the fall of 1948 further interviews were made by agents of the Service to bring to light any further information which might be available and as a guide for use in the future exploratory fishing operations.

1/ "The Alaskan King Crab", Fishery Market News, May 1942 Supplement, Fish and Wildlife Service.

2/ "A Preliminary Report of the Fishery Possibilities of the Nome Area", September 1945, Fish and Wildlife Service.

Prior to the war, the operation of foreign factory ships in waters adjacent to Alaska had been noted. This may be construed as further evidence that substantial fishery resources probably exist in the area. The existing fisheries in Alaska are confined chiefly to inland waters and waters near shore. Present fishing areas also include the Bering Sea from Unimak Pass to and including Bristol Bay; however, the offshore waters and the Bering Sea north of the Pribilofs are practically unexplored.

Necessity for Exploring Area

As so little is known of the fisheries of the Norton Sound to St. Lawrence Island region of the Bering Sea, this area seemed deserving of particular attention in starting exploratory fishing operations. Unverified reports have indicated the presence in commercial quantities of king crabs, shrimp, clams, cod, herring, halibut, and flounder in the St. Lawrence Island, King Island, and Nome areas. It seemed highly desirable to investigate this food fish resource in an effort to ascertain its extent and location.

To a large extent the natives of the Seward Peninsula have adopted the white man's food habits and are dependent on food shipped in. They supply very little of their own food by direct production. It was also pointed out by informed residents of the area that the loss or reduction of the reindeer herds has greatly reduced the amount of protein food available to the natives. Using crude fishing methods, the natives have been able to supply themselves with limited amounts of fish and crabs. (See Fig. No. 1) The discovery of fishing grounds and the development of improved methods of taking fish and shellfish, would react to the benefit of the population in the area.

A quantity of fresh fish and shellfish could be readily marketed in the local communities, thus providing income to the fishermen, and a good source of domestically produced protein food for the residents. Boat operators in Nome evinced interest in developing a small fishery if crabs, flounder and cod were found near-by. It should be pointed out that to make this possible, suitable fishing gear would have to be designed or adapted for the available boats. It must also be recognized that the Nome harbor is limited to vessels of six foot draft, that the fishing areas are all in exposed waters (frequently stormy), and that it may not be possible for a sustained fishing effort to be made by vessels of such limited size. However, if sufficient quantities of crabs, shrimp and fish were found to exist in the Norton Sound area to warrant commercial fishing for them by local small boats, this could well provide at least a part time activity for these vessels, and the additional industry would be of economic benefit to the local communities. Crab and shrimp command a high price per pound so that it may very possibly be economically practical to transport these commodities to market by air. Probably the larger Alaskan cities such as Fairbanks and Anchorage,which are linked to Nome by established commercial airlines, would be able to absorb considerable quantities of these specialty products.

Another important subject about which practically no information is available is the migration of food fish and king crabs in the area. Evidence exists that these fish may be found at certain times, but much work must be done to determine migratory patterns for the various species. A sustained exploratory fishing effort should reveal information of value in this connection, while factual information gained from the Alaska king crab investigation previously cited would be expanded.

Closely allied to the exploratory fishing investigation in the area are observations and studies looking toward the development of new and improved fishing gear. Most fishing gear now in use has been developed by trial and error methods and little scientific thought has been devoted to an analysis of the hydrodynamic and engineering principles involved.

In addition to studying the best type of fishing gear for exploratory and commercial fishing in the area, it is necessary to determine what type of vessel will operate most efficiently there. As this area would come within the scope of the exploratory investigation, and as the Service was in the process of acquiring an exploratory fishing vessel for long-term use in its work, this knowledge was of vital concern in determining the type of fishing vessel needed.

Practically no oceanographic information is available for the area. It was planned that the crew of the exploratory vessel would secure as much of this type of information as possible, particularly that part which is of most value to the commercial fisheries.

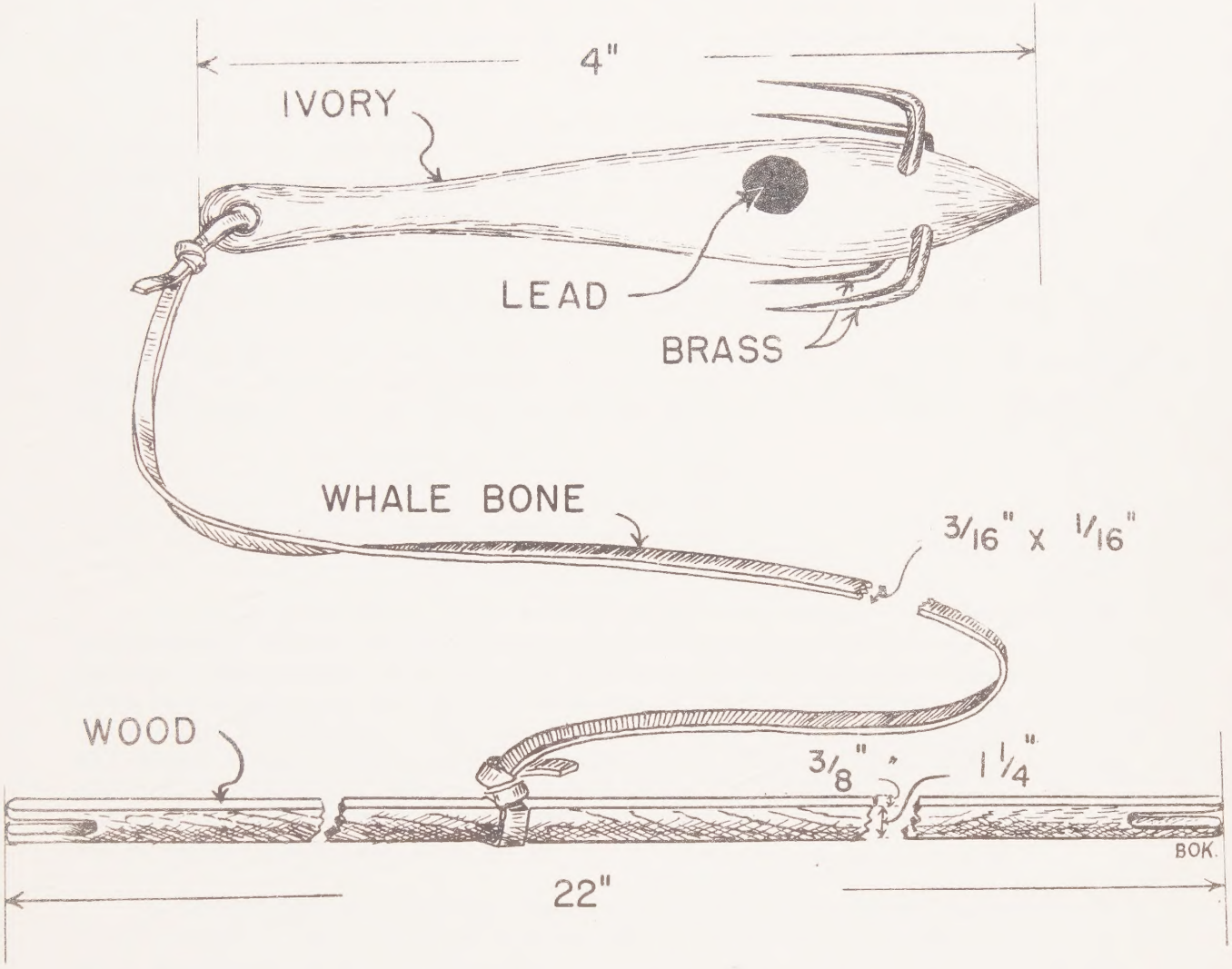
Any authentic information concerning the nature and habits of the fish populations accumulated during the trips would be available for use by the Service when establishing regulations if needed in the future.

Need for Technological Investigation of the Fisheries

In conjunction with the actual exploratory fishing, it was planned to carry on experimental technological work at sea. It has long been recognized that equally as important as locating and catching fish is the need to properly handle these fish on shipboard, transport them to the primary marketplace, and deliver them ashore in good condition. Inquiries frequently are addressed to the Fish and Wildlife Service technological laboratories in regard to recommended methods and procedures. Proper and suitable processing methods for use aboard ship must be considered. The best way to experiment with such matters, it was felt, would be aboard the exploratory vessel while at sea. Further studies of processing methods, packaging techniques, storage life, food value, and consumer use of products must be continued ashore.

Matters coming within the scope of the investigation, then, either on the first trip or in the future, would include recommendations for freezing or canning of king crab, and investigations of the proper procedures for the preservation and transportation of the flatfish resource. Some work had already been done concerning the freezing of flatfish in the round, with

FIG. 1



NATIVE FISHING GEAR, NOME ALASKA

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subsequent thawing, filleting, and refreezing of the product.[3] The average size, yield, and marketability of food fish from each area must be determined in considering economic possibilities. It was proposed to carry on with this study.

Other contemplated work included experimental methods of freezing, particularly in regard to the adaptability of freezing Alaskan fish in brine, with a view to the utilization of such information by existing tuna type boats. The technological investigations would result in recommendations for processing of fish, and for refrigeration equipment to be used in this fishery. Incidental to this, it was expected that some work would be done with salting and curing of fish.

Studies of the possible value of by-products from a trawl fishery in the area are of importance in assuring full utilization of the resources. Immediate factors for study include oil and meal recovery from crab and fillet waste and the vitamin A content of the livers and viscera from the common fish species.

First Exploratory Trip of U.S. FWS Washington, Fall of 1948

This vessel had been built for and operated by the Pacific Exploration Company, in conjunction with the factory vessel, S.S. Pacific Explorer.[4] The Washington, 158 net tons, is of the following approximate dimensions:

L.O.A.	100'
L.B.P.	98' 8"
Beam, moulded	26'
Depth	13' 9"

It has a steel hull with double bottoms throughout, and with wooden deckhouses. There are accommodations for four men topside and for ten in the main deckhouse. Powered with a 600 H.P.. supercharged main engine, it also has as auxiliaries two 50 KW diesel-driven generators. Refrigeration is handled by two $5\frac{1}{2}$" x $5\frac{1}{2}$" compressors. Six brine wells, fully insulated and steel lined, have a combined capacity of 5875 cu. ft., while the insulated refrigerated cargo hold has a capacity of 3655 cu. ft. It has bunkers for 16,800 gals. of diesel fuel, and 1200 gals. of lubricating oil. Fresh water tanks hold 2600 gals.

Although the exploratory vessel, Washington, was acquired quite late in the season, and its departure on its first voyage was necessarily further delayed because of the need for alterations, acquisition of fishing gear and crew, and outfitting, nevertheless it was determined to sail the vessel on its first voyage to the northern Bering Sea area. The Washington was an untried vessel for this type of work, and the area to be worked was

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3/ "Can Fish be Frozen Aboard Vessel, Thawed, Filleted and Refrozen Ashore?", by Stansby, M. E., and Dassow, John, Pacific Fisherman, 46, No. 4, P. 65 (March 1948).

4/ "S.S. Pacific Explorer" - A Preliminary Description - by Carl B. Carlson, Commercial Fisheries Review, 9, (#1), pp. 12-17 (Jan. 1947).

also almost completely an "unknown quantity". It was of importance to determine the suitability of the vessel for the work in question, and inasmuch as some of the future work of the exploratory vessel would be done in this area, it was decided to send the vessel to the Bering Sea and try it out under conditions which should be equal to the worst the vessel would be likely to encounter later.

Accordingly the vessel was manned and outfitted, and left Seattle on its first voyage August 24, 1948. (See Fig. No. 2) Making stops enroute at Ketchikan, Kodiak, and St. Paul Island, the vessel arrived at Nome September 12, 1948. Because of weather conditions, fishing could not be started until September 14. A course was set for St. Lawrence Island September 18, fishing enroute. Weather conditions being too severe to permit further fishing, the vessel was sailed to St. Paul, where it arrived September 21. On October 1, the vessel departed from Akutan enroute to False Pass. Stops were made, either to get information, or in the process of fishing, at Pavlof Bay, Sand Point, Perryville, and Kodiak Island. The vessel left Kodiak southbound October 16, and arrived back in Seattle October 23. The distance covered on the first trip was 6185 miles.

On the voyage the only fishing gear used were stern set otter trawls. These were "Atlantic" type trawls, of the size commonly known as 600 meshes around the throat. Specifications for these nets follow:

Lines:

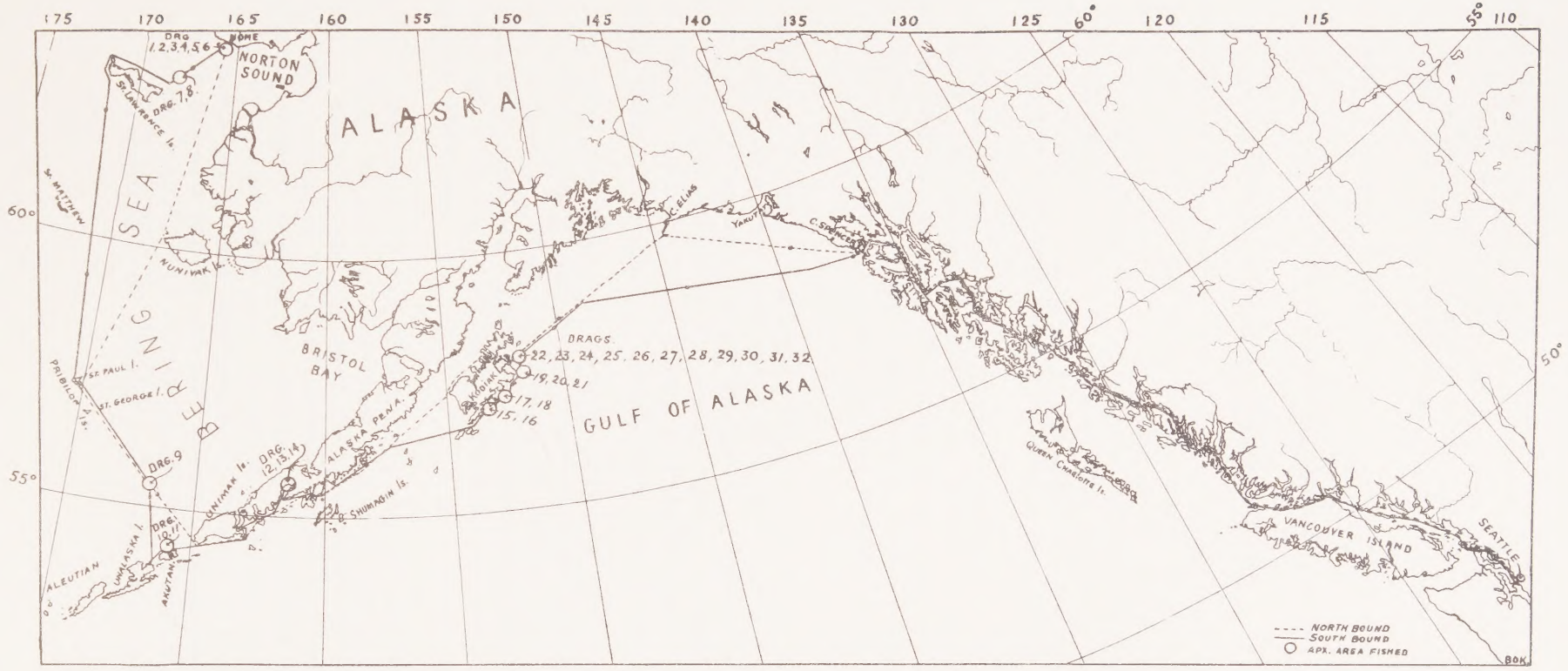
Length of head line	111 feet
Length of foot line	138 "
Length of breast line	14 "
Rope serving on head line	6 thread
Rope serving on foot line	27 "
Rope serving on breast line	6 "

Head line - 6/19 3/8" diameter plow steel, galvanized
Foot line - 6/24 1/2" diameter plow steel, galvanized
Breast line - 6/19 3/8" diameter plow steel, galvanized

Mesh Size and Weight:

Top wings	$4\frac{1}{4}$"mesh	36 thread
Bottom wings	" "	48 "
Square	" "	36 "
Top belly	" "	36 "
Bottom belly	" "	48 "
First intermediate bag	$3\frac{1}{2}$" "	60 "
Second intermediate bag	" "	84 "
Fish bag	" "	96 "

FIG. 2



ITINERARY OF M/V WASHINGTON

The first and second intermediate bags and the fish bag were each 60 meshes long and 80 meshes around. The necessary tapering to achieve a fish bag 80 meshes around was carried into but not beyond the first intermediate bag. After fishing the net for several drags, 20 additional meshes were added in the fish bag to achieve a bag 100 meshes around.

Trawl doors were standard doors, 4' x 8', weighing 700 pounds each.

Wire rope used was 6/19 black plow steel, 5/8" diameter.

Exploratory Fishing in the Bering Sea

Fishing operations commenced in the vicinity of Nome on September 14th. (See Fig. No. 3) The first set was made to the south of Sledge Island, in position Lat. 64° 22.5' N., L. 166° 15' W., towing on SW course for 45 minutes at speed of 2 knots. Depth was 17 fathoms, bottom temperature was 5.3° C., and a bottom sample showed brown mud with black specks. The drag produced only one 7" smelt and numerous jellyfish.* It was decided to remove some floats from the net, and to reduce towing speed for the next try.

Set No. 2 was made to the south of Sledge Island in position Lat. 64° 10' N., L. 166° 22' W., on northeasterly course for 50 minutes at 1 3/4 knots. Soundings showed 14 fathoms, brown mud with black specks, and bottom water temperature of 4.9° C. This set caught 12 small tomcod, 4 herring, 1 halibut weighing 6 pounds, 5 shrimp, and a great many purple and basket starfish.

Set No. 3 was made somewhat closer to Nome in position Lat. 64° 15' N., L. 166° 11' W., on NE course for 45 minutes at 1 3/4 knots. Soundings showed 14 fathoms, mud bottom with black specks, and bottom water temperature of 5.45° C. This drag produced 110 small tomcod, 1 small halibut, 1 lemon "sole", 4 starry flounder, many pink and gray shrimp, 1 female purple king crab (Paralithodes platypus) and a great many starfish.

Set No. 4 was made yet closer to Nome in position Lat. 64° 23' N., L. 165° 49' W., on ENE course, towing for 35 minutes at 2 knots, and bottom water temperature of 5.6° C. Soundings showed 14 fathoms, mud bottom with black specks. This drag resulted in 6 female purple king crabs (Paralithodes platypus), 12 herring, 3 smelt, 1 pollock, more than 60 small tomcod, many shrimp, and numerous starfish.

The first four tows made by the exploratory vessel had been made in the close proximity of Nome, because of the encouraging reports as to possible fishery resources in the area and the fact that it would be beneficial to the community if such resources could be located close to Nome. Reports concerning shrimp had seemed especially interesting, as this commodity should command a ready market at a good price, and is capable of being shipped by air. Therefore, it was determined to attempt a drag near the Nome roadstead, with the cod end of the net backed up with herring web, in order to offer a better opportunity of retaining any shrimp which might enter

* See Table No. 1 for enumeration of species and scientific names.

the net, as well as some of the other small fish of which a meager sample had already been obtained.

Set No. 5, in position Lat. 64° 29' N., L. 165° 31' W., was made on WSW course with speed of 1 3/4 knots. Soundings showed 10 fathoms gray sand with black specks. A strong current was setting westward, as in all the drags made thus far. After towing 40 minutes the net hung up badly. Only a few small tomcod, one greenling, several mangled pink and gray shrimp and starfish were found in the cod end.

September 16 and 17 were devoted to mending the torn gear, as the weather was too rough for fishing. On September 18, a course was laid from Nome to Northeast Cape, St. Lawrence Island, with several tows scheduled for the passage across. Reports had been received in Nome that codfish were plentiful in this area at times, but in general, little was known about the population of food fish in these waters.

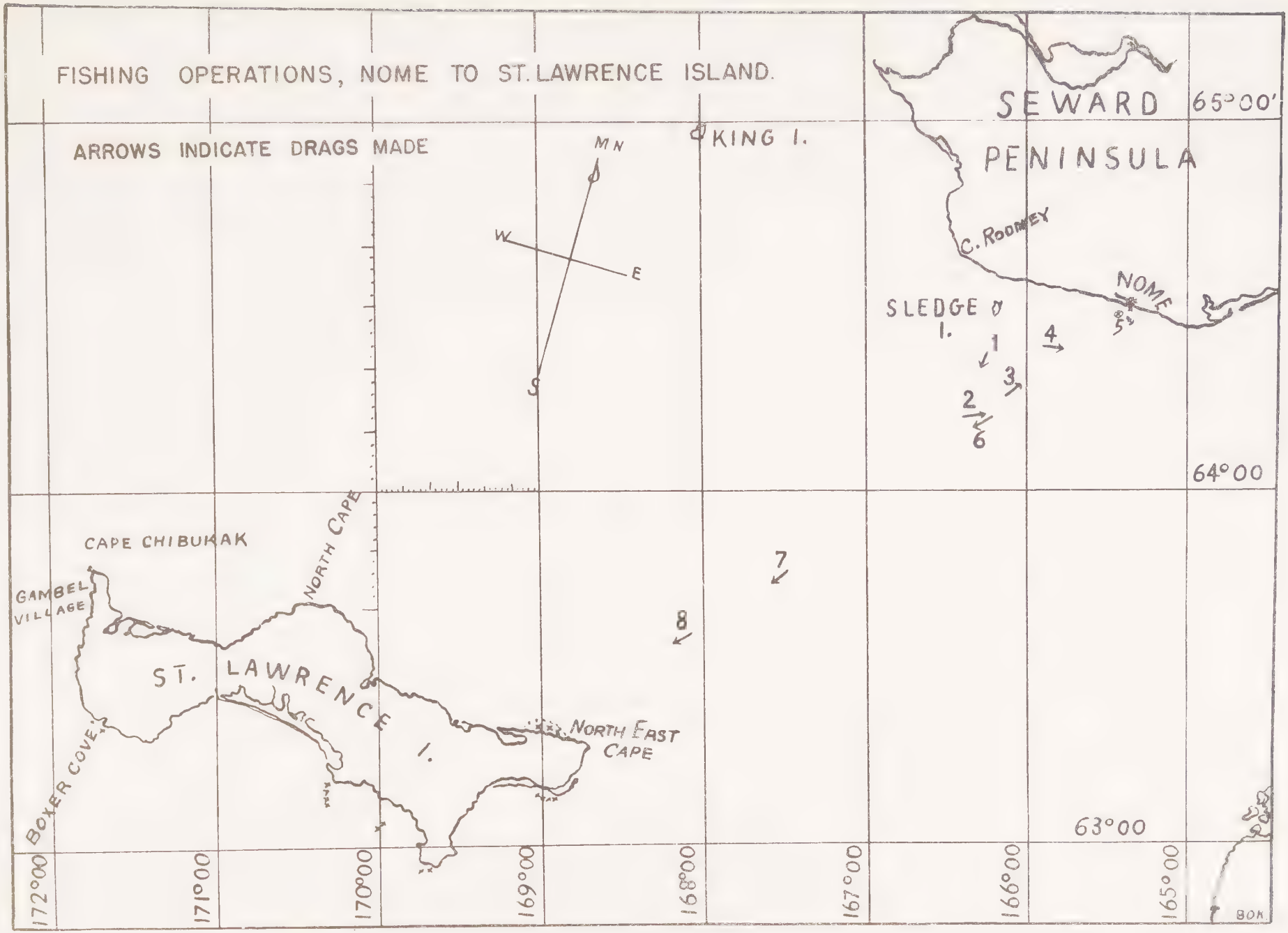
Set No. 6 was made in position Lat. 64° 11' N., L. 166° 15' W., towing SSW for 30 minutes at 1 3/4 knots. Soundings were 13½ fathoms, gray sand with black specks, and bottom temperature 5.2° C. The catch comprised 3 starry flounder, 4 female purple king crabs, 12 shrimp, and many sculpin, small tomcod, and starfish, as well as a considerable number of jellyfish.

Set No. 7 was made in position Lat. 63° 46' N., L. 167° 28' W., towing SW ½ W at 1 3/4 knots for 50 minutes. Soundings indicated 16 fathoms, dark brown sand with black specks, and bottom water temperature 6.3° C. (Note the warmer water). This tow produced the first codfish caught so far on the trip. The tow produced 1 cod weighing about 11 pounds, and several small cod, 2 lemon "sole", 2 rock flounder, 12 small herring, and several smelt and small tomcod. Starfish were only a few in number on this drag. For the first time on the trip the grounds seemed promising. Possibly the warmer water temperatures accounted for the better showing. In any event, it seemed likely that at certain times of the year, with the right weather conditions, this could be a productive ground.

Set No. 8 was made in position Lat. 63° 37' N., L. 167° 30' W., towing for 45 minutes at 1 3/4 knots on course WSW. Soundings showed 18 fathoms, bottom dark brown sand with some pebbles, bottom water temperature 6.3° C. Caught in this drag were the following: 1 small halibut, 12 large codfish, 3 starry flounder, 20 sand "sole", 3 lemon "sole", and a large number of small tomcod and sculpin.

Market fish produced by the last two drags were of extremely fine quality. However, before the drag was completed, the wind had freshened up and the sea was rough. While examining the catch, a sea came over, washing most of the fish overboard. Observed in the contents of the last drag were some skates and sea grass which might be indicative of good fishing grounds. Local inhabitants had reported that codfish had often been found on a sea grass bottom.

FIG. 3


FISHING OPERATIONS, NOME TO ST. LAWRENCE ISLAND.
ARROWS INDICATE DRAGS MADE
MN
W
E
S
KING I.
SEWARD
PENINSULA
65°00'
C. ROONEY
NOME
SLEDGE I.
1
2
3
4
5
6
64°00
CAPE CHIBUKAK
NORTH CAPE
GAMBEL VILLAGE
ST. LAWRENCE I.
BOXER COVE
NORTH EAST CAPE
7
8
63°00
172°00
171°00
170°00
169°00
168°00
167°00
166°00
165°00
BOK

As a stop had been scheduled at Gambell on St. Lawrence Island, and radio advice of an approaching gale from the SE had been received, nets and equipment were secured and a course laid for the northern shore of St. Lawrence Island for protection against the coming storm. However, by early morning while laying off the Village of Gambell awaiting daylight, the wind hauled to the north, and almost immediately landing conditions became impossible. The wind was of full gale force, and in the extremely shallow water, it was very rough. It was decided to seek shelter at Boxer Cove on the leaside of the island. However, when this was reached, snow squalls made visibility too poor to attempt entering. Meanwhile, radio contact had been made with the weather station at Gambell, which advised that this storm would last for several days. The vessel was laboring badly, and it was impossible to take shelter. Since no fishing could be accomplished, it was decided to take advantage of the following wind and sea and work somewhat to the southward. Accordingly, a course was laid for St. Paul Island, and under extremely rough and stormy conditions the vessel covered this distance, and anchored at St. Paul on the morning of September 21.

Since it had been impossible to land at Gambell Village, contact was made with the government radio there, and with the cooperation of the government school teacher, it was possible to secure a considerable amount of fisheries information from the resident natives. An unfortunate result of the storm was the loss overboard of all biological samples collected to date, although it had been thought that they were well secured. This made complete classification and identification of samples impossible, as no biologist had been available to accompany the vessel. A great number of birds and gulls were observed feeding during the run from St. Lawrence Island to St. Paul, particularly in the vicinity of St. Lawrence Island, which could indicate the possibility of more successful fishing in this area than had been found heretofore.

In the afternoon of September 21, the weather showed signs of moderating, so it was decided to run somewhat to the south and work near the 100 fathom curve. (See Fig. No. 4) The vessel was run at less than usual speed in order not to arrive on location before daylight. By morning, the weather was much less favorable. However, a set was made.

Set No. 9 was made in position Lat. 55° 28' N., L. 166° 59' W. Soundings showed 75 fathoms, dark mud bottom, and bottom water temperature of 4.25° C. The net was towed NNE for 60 minutes at 2 knots. The drag produced 2 small cod, 8 pollock, about 100 mixed arrow-toothed flounder and small yellowfin "sole", 4 large skates, 12 tanner crabs, and a good sized octopus. It was extremely difficult to examine or analyze this catch because by the time the net was in, the sea was quite rough; several seas came over and washed most of the fish overboard.

As it was too rough to attempt further fishing, (the net had been retrieved with great difficulty from the last haul) it was determined to run to Dutch Harbor and attempt to fish the 100 fathom curve from some base where shelter was afforded in stormy weather. Heading into an extremely heavy southeasterly storm, which made it necessary to reduce the speed of the vessel, arrival at Dutch Harbor finally was made on September 23. The weather

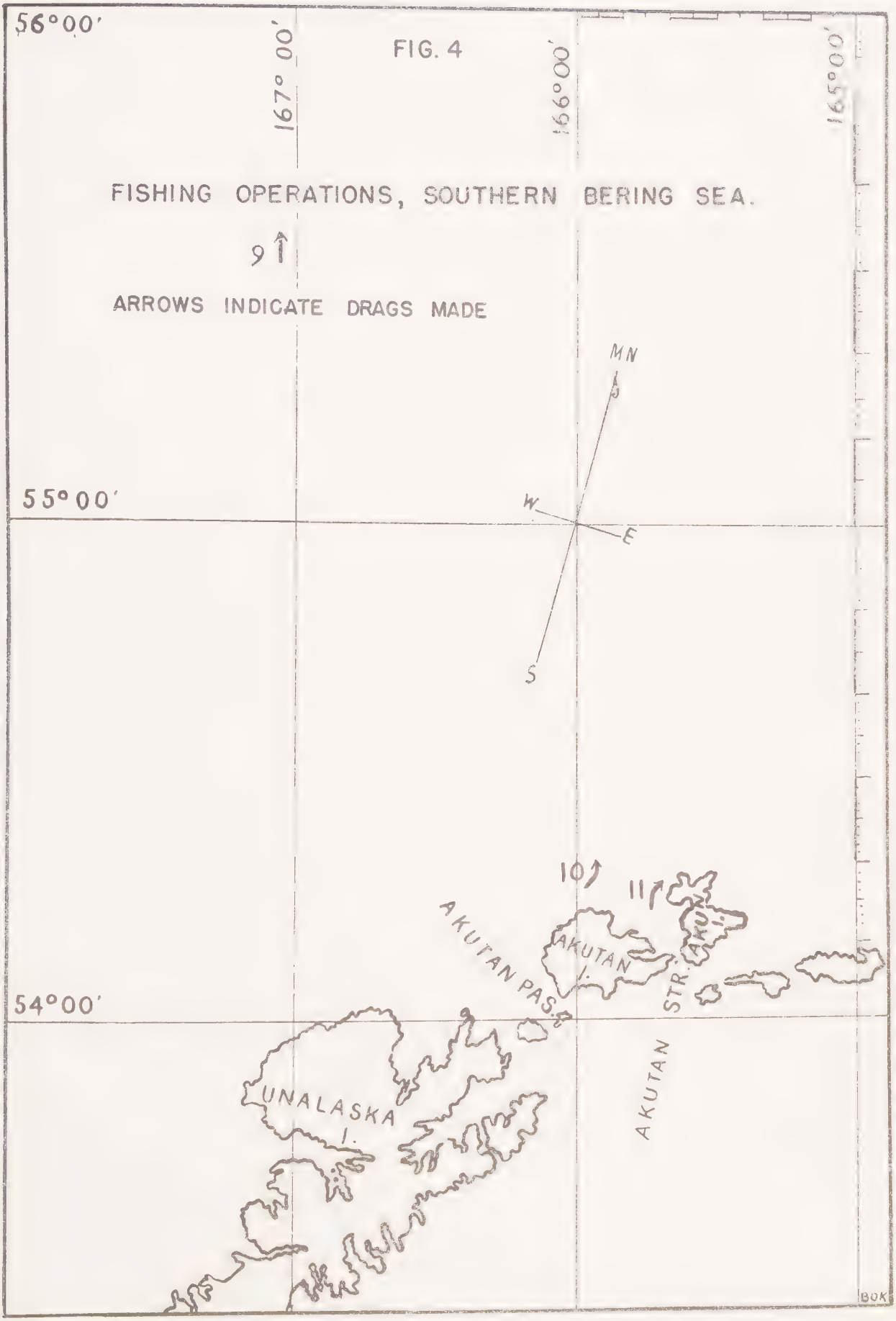
remained too severe for fishing until September 26. While delayed by weather, the storm damage was repaired, and 20 additional meshes were added to the cod end of the net. On the 26th, the vessel moved to Akutan in the hope that this location could be used as a base of operations. Meanwhile, information pertaining to the fisheries had been obtained from the local inhabitants at Unalaska and Akutan Villages. The information indicated a marked dearth of herring and codfish resources, and a very great increase in the hairseal and sea lion populations.

As it was too rough for fishing operations on September 26 or 27, the next drag was not made until September 28. Set No. 10 was made about three miles north of North Head, Akutan Island, in position Lat. 54° 17' N., L. 165° 57' W. (See Fig. No. 4) Soundings showed 57 fathoms, with bottom water temperature 5.95° C; bottom, black sand and gravel with broken shells. The course was ENE, and time on bottom was 50 minutes at a speed of 2 knots. The drag produced one 45 pound halibut, 2 immature halibut, 4 dover "sole", 400 pounds of small rock "sole", 400 pounds arrow-toothed flounder, 24 Korean horse crabs (Erimacrus isenbeckii), 3 small codfish, and numerous tanner crabs.

Although this set had been made during the only break in the weather for some time, it was already starting to breeze up again. Nevertheless, Set No. 11 was made in position Lat. 54° 15' N., L. 166° 44' W., at 2 knots, towing NNE. Soundings showed 55 fathoms, black lava sand bottom, and bottom water temperature 6.45° C. After 50 minutes on the bottom the net was hauled in and showed 1 - 25 pound halibut, 20 immature halibut about 12 inches long, a considerable number of arrow-toothed flounder, about 300 pounds of mixed rock and flathead "sole" (of which only a few were of market size), 3 small cod, 1 pollock, and about 18 Korean horse crabs (E. isenbeckii). It was extremely difficult to identify the catch, as by the time the net was on board it had become quite rough, and with the decks awash, most of the catch was washed overboard.

The weather remained extremely stormy until October 1. This made it necessary to remain idle in the shelter of Akutan Harbor, where several other vessels were also stormbound. Meanwhile, in view of the poor fishing possibilities offered by the continued bad weather, it had been determined to move to the Kodiak Island area with a few stops scheduled enroute.

Certain facts and conclusions stand out as being of the most importance in considering the work done in the Bering Sea. First, the matter of weather must be considered, for while it was unfortunate that during the time the Washington was in the area, unusually severe weather occurred, nevertheless it seems clear that weather conditions are a factor which must be considered if commercial fishing is to be carried on there, particularly in the northern parts. The Nome-Norton Sound-St. Lawrence Island area offers no harbors, docks, or repair facilities. The water is generally shallow, and violent winds of shifting directions arise with little warning. Thus to work in the area, the fishing vessel should have excellent sea qualities and be practically self sufficient (i.e., to be able to carry with it all necessary reserve


56°00'
167° 00'
FIG. 4
166°00'
165°00'
FISHING OPERATIONS, SOUTHERN BERING SEA.
9
ARROWS INDICATE DRAGS MADE
MN
55°00'
W
E
S
10
11
AKUTAN PASS
AKUTAN I.
AKUTAN STR.
54°00'
UNALASKA I.
AKUTAN
BOK

fuel, water, equipment, gear, etc.). It must be designed so that it is able to fish under stormier conditions than the usual purse-seine type of vessel, and for trawling, there appears to be little doubt that the East Coast trawler type of ocean-going vessel is the most suitable vessel for the work.

The catches made by the exploratory vessel showed an assortment of scattered fish, several commercial species of shrimp, the purple species of king crab (all king crabs caught were female) in the area from Nome to St. Lawrence Island. Considering the weather conditions encountered (mostly easterly winds of high intensity); the depth of water being fish (all an extremely shallow continental shelf); the time of year (late fall, when migratory fish would be inclined to seek deeper water before the winter freeze-up set in), the very sketchy returns should not be taken with undue pessimism. The wealth of bottom life and the considerable number of small feed fish encountered in the drags would indicate that stable populations of large food fish could be supported. Work in the area in the late spring or summer could well show substantial populations of king crabs, shrimp, cod, and edible flatfish. Norton Sound appears to offer possibilities in this direction.

The area in the vicinity north of St. Lawrence Island gave the most promise for codfish. Doubtless, Bering Straits' currents meet the warmer currents from the south somewhere in this area, providing eddies of mixed temperatures. Temperature readings taken by the exploratory vessel would tend to confirm this belief, and catches made by the vessel were of high quality. No drags were made to the south of St. Lawrence Island, but great numbers of feeding birds were seen, which could be taken as possible indication of good fishing in the area. It appears possible that to the south of the Pribilofs along the 100 fathom edge extending to the Aleutian Islands, good fishing might be found at the right time of year, probably around August.

It would seem reasonable that weather conditions should have great influence on fish locations in the Bering Sea. The continental shelf is extremely shallow, long, and wide, with the depth tapering off to the westward. The strong winds, which, during the first voyage were mainly easterly, probably create strong currents which affect the habits and location of fish. For example, it is well known that the winds can materially change the depth of water in the Nome roadstead and in Norton Sound.

Exploratory Fishing South Side of Alaska Peninsula to Kodiak Island

On October 1, the vessel left Akutan enroute to False Pass. Between Akun Head and Scotch Cap, and from Cape Lutke to Cape Lazaref, many feed birds were observed working, possibly indicating the presence of herring. Information was gathered at False Pass concerning the local occurrence of herring. Then the vessel proceeded to Pavlof Bay, where fishing commenced October 3. (See Fig. No. 5) The purpose of this fishing was to secure information concerning king crabs at this season of the year in this known producing area.

Set No. 12 was in position Lat. 55° 32' N., L. 161° 34' W., towing NNE for 60 minutes at 2 knots. Soundings indicated 24 fathoms, lava mud bottom and bottom water temperature, 7.3° C. The drag produced 10 male king crabs and 14 female king crabs (P. camtschatika), 50 or 60 infant king crabs (mostly female), 4 chicken halibut averaging 10 pounds each, 20 infant halibut, and about 50 mixed yellowfin and rock "sole" of 14" length and less.

Then, the tide being favorable, the vessel entered Canoe Bay for Set No. 13, made in position Lat. 55° 35.5' N., L. 161° 19.5' W. towing eastward for 60 minutes at a speed of 1 3/4 knots. Soundings showed 35 fathoms, lava mud bottom, and bottom water temperature, 7.7° C. This drag resulted in the capture of 3 male king crabs, 100 female king crabs, and 15 tanner crabs. Many small pink shrimp (mostly Pandalus borealis) were also caught.

Returning to Pavlof Bay, Set No. 14 was made in position Lat. 55° 36' N., L. 161° 00' W., towing SSE for 90 minutes at 2 knots. Soundings averaged 14 fathoms on lava mud bottom. The catch resulted in 1 male king crab, 56 female king crabs, 1 infant male king crab, about 100 mixed rock and yellowfin "sole", and several lemon "sole". Most of these flatfish were small. Also caught were 2 small halibut, 12 infant halibut, and 14 tanner crabs.

The most noticeable observation from the fishing in Pavlof and Canoe Bays was the preponderance of female king crabs over male, especially in Canoe Bay. Whether this is due to the heavy fishing for crabs which permits the taking of the male while releasing the female, or is due to seasonal migration, cannot be asserted. Also the numerous infant king crabs and halibut taken would lead to the suspicion that this is a nursery area, at least at this season.

Enroute to Kodiak Island, stops were made at Sand Point and Perryville to obtain information from the local inhabitants concerning the fisheries. Reports were again received concerning the reportedly great increase in the sea lion population. Abeam of Mitrofania Island, many birds were observed working on feed of some kind, possibly herring.

The Alaskan King Crab Report[5/] stated that the area from Kaguyak Bay to Sitkalidak Strait was the only section in the Kodiak area that produced entirely negative results in regard to king crabs, and also poor results for flatfish, although somewhat better results for flatfish were recorded in Rolling Bay and Natalia Bay. As this work had been done in March 1941, it was decided to briefly review some of the area to determine what, if anything, might be revealed in October.

Therefore, 3 tows (See Fig. No. 6) were made. In Kaguyak Bay, No. 15 was made in position Lat. 56° 53' N., L. 153° 45' W., towing NE to N at a speed of 2 knots for 60 minutes. The depth varied from 17 to 32 fathoms on a mud and shell bottom, with bottom water temperature of 8.2° C. Tow No. 16 was made in Rolling Bay in position Lat. 57° 02' N., L. 153° 21' W., towing SxW for 45 minutes at slightly less than 2 knots. Depth varied from 15 to 24 fathoms on sand and shell bottom, with a bottom water temperature of 7.95° C. Tow No. 17, in Sitkalidak Straits, was made in position Lat. 57° 10' N., L. 153° 20' W., towing southward for 60 minutes at 2 knots. Soundings showed 65 fathoms, gravel and shell bottom, and bottom water temperature

5/ Op. cit.

FIG. 5

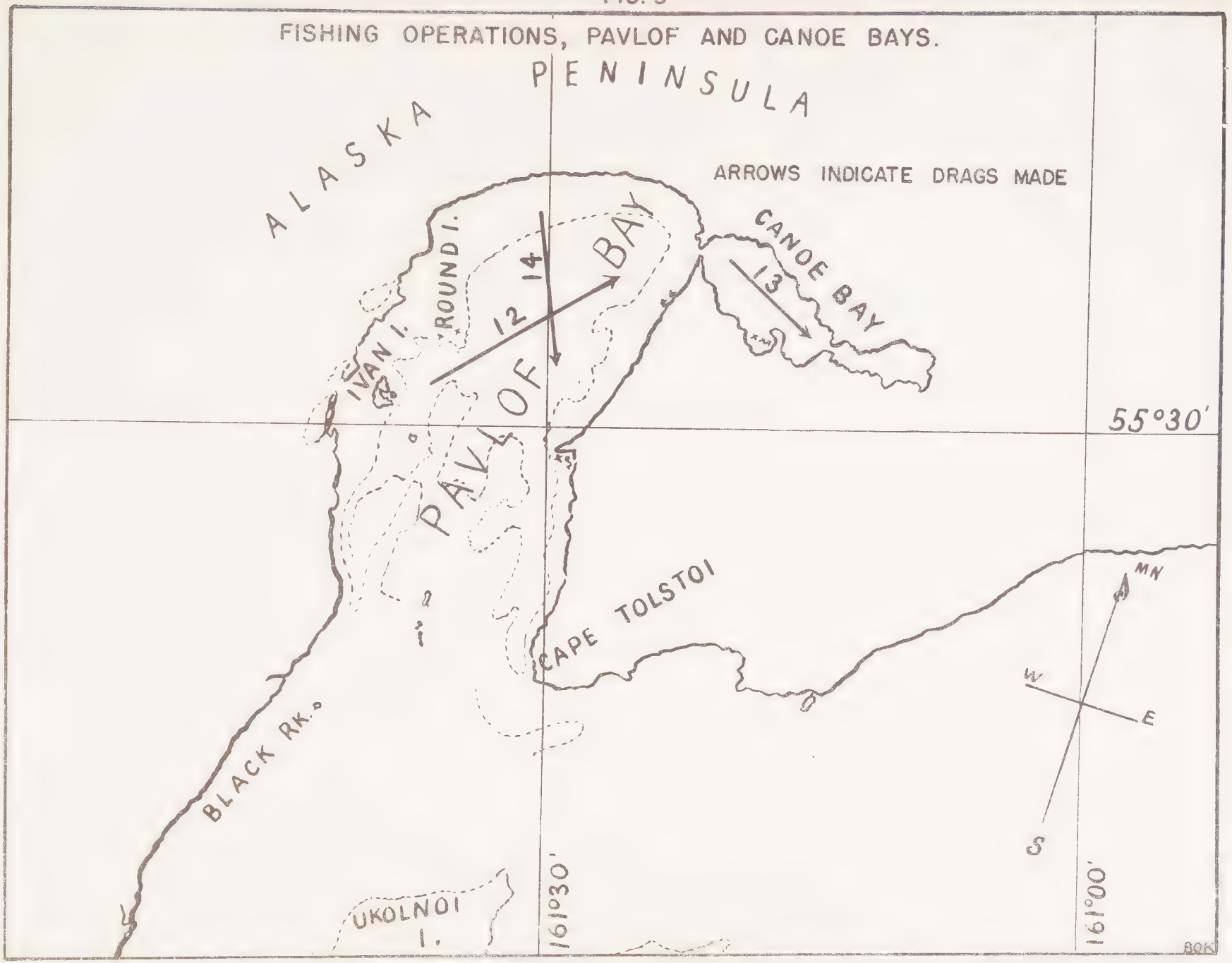
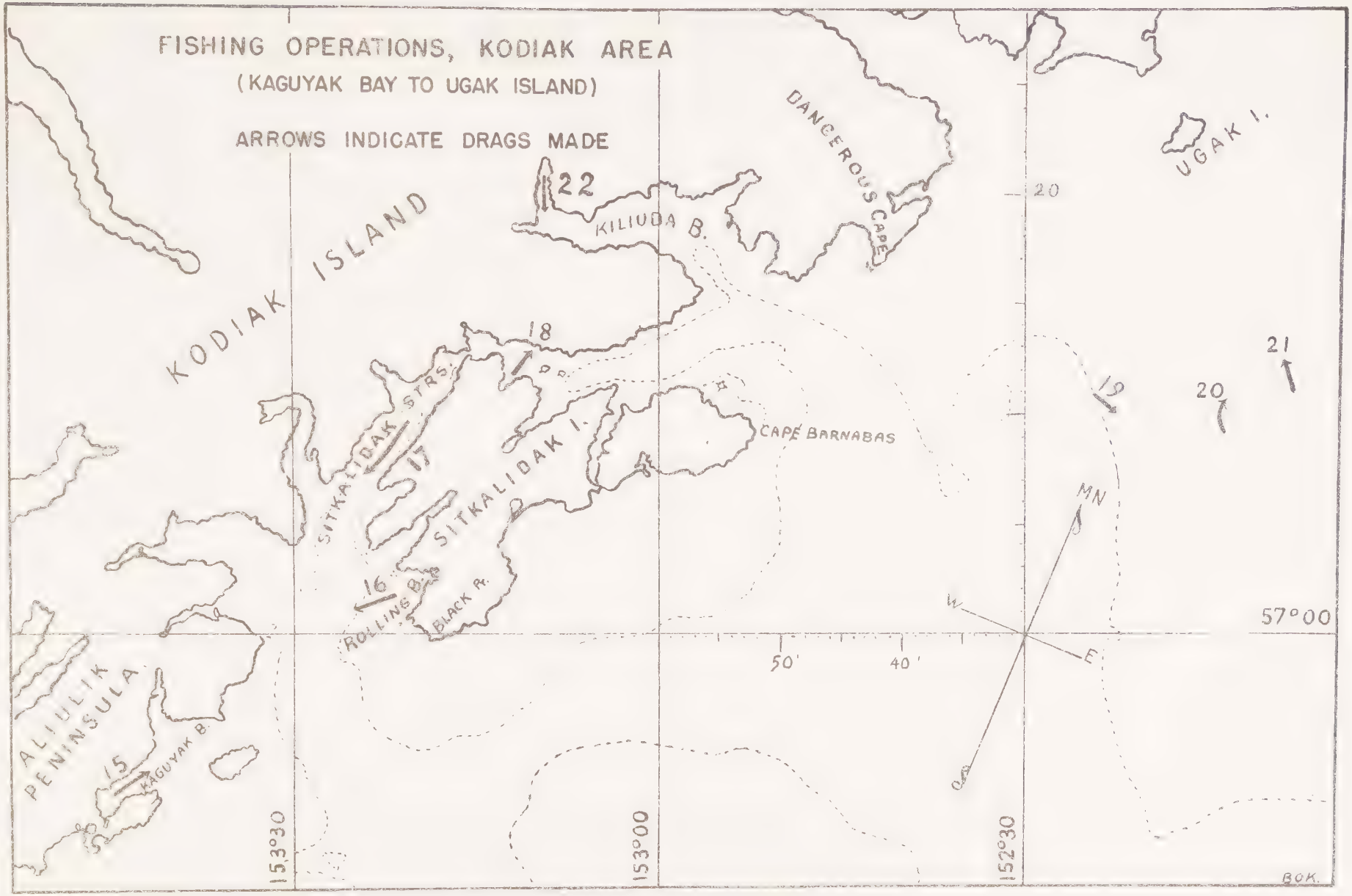

FISHING OPERATIONS, PAVLOF AND CANOE BAYS.
ALASKA PENINSULA
ARROWS INDICATE DRAGS MADE
IVAN I.
ROUND I.
PAVLOF BAY
CANOE BAY
12
14
13
55°30'
CAPE TOLSTOI
BLACK RK.
UKOLNOI I.
161°30'
161°00'
MN
W
E
S

FIG. 6


FISHING OPERATIONS, KODIAK AREA
(KAGUYAK BAY TO UGAK ISLAND)
ARROWS INDICATE DRAGS MADE
KODIAK ISLAND
KILIUDA B.
DANGEROUS CAPE
UGAK I.
SITKALIDAK STRS.
SITKALIDAK I.
CAPE BARNABAS
ROLLING B.
BLACK R.
ALIULIK PENINSULA
KAGUYAK B.
22
18
17
16
15
19
20
21
MN
W
E
57°00
50'
40'
153°30
153°00
152°30
20
BOK.

of 8.00° C. Results of these drags were poor, resulting in only a few halibut, dungeness crabs, and flatfish of marketable size. Starry flounder, few yellowfin, lemon, flathead and sand "sole" predominated, the latter coming mainly from Rolling Bay. A few small red rockfish (Sebastodes sp.) and two small cod were also caught. Most of the "sole" and flounder were small and thin, except for the sand "sole" from Rolling Bay, which were prime. No king crabs were caught in any of the drags.

The Alaskan King Crab Report[6/] also indicated that in March and April king crabs had been found in Amee Bay and Kiliuda Bay. A marked decrease in abundance had been noted in April as compared with March. As it was considered desirable to try these areas also in October, Set. No. 18 was made in Amee Bay in position Lat. 57° 12' N., L. 153° 12' W., towing NxE for 30 minutes at 1 3/4 knots. Soundings showed 9 fathoms, black mud and broken shell bottom, and bottom water temperature, 8.6° C. This drag resulted in no king crabs, and very few flatfish. Two small halibut, and a few starry flounder were caught, together with about fifty pounds of small yellowfin and rock "sole". The drag produced mostly kelp. Drag No. 22 was made in the NW arm of Kiliuda Bay in position Lat. 57° 21' N., L. 153° 09' W., towing SExS at 1 3/4 knots for 60 minutes. Soundings were 12 fathoms at start, and 33 fathoms at finish of tow on broken clamshell bottom, with water temperature, 7.8° C. This drag produced no king crabs. About 15 dungeness crabs and a few tanner crabs were caught. Numerous very small yellowfin "sole", a few good sized starry flounder, and about thirty pink shrimp were also caught. Advantage had meanwhile been taken of good weather to make drags 19, 20 and 21 in offshore waters, during the time intervening between No. 18 and 22. (See Fig. No. 6)

Sets No. 19, 20 and 21 were each towed at 2 knots for 60 minutes, and were made offshore in the following positions: No. 19: Lat. 57° 11' N., L. 152° 24' W., towing ExN; 44 fathoms, gray sand, bottom water temperature, 7.2° C. No. 20: Lat. 57° 08' N., L. 152° 13' W., towing NW; 43 fathoms, fine sand with black specks, bottom water temperature 6.8° C. No. 21: Lat. 57° 11', L. 152° 08' W., towing W; 43 fathoms, gray sand, bottom water temperature, 7.25° C. These drags produced very few fish of marketable size or quality. In all, about 1500 pounds of flatfish, (mostly flathead, yellowfin, rock "sole", and a few English and Dover "sole") were brought on board. Most of these fish were too small and thin for market use. In addition, a few small cod, halibut, and several tanner crabs were caught. The results were considered quite poor.

The area from Cape Chiniak to Marmot Island was next investigated. A total of ten drags was made in this section (as shown on Fig. 7). Set No. 23 was made in position Lat. 57° 51' N., L. 151° 50' W., towing SE for 60 minutes at 2 knots. Soundings indicated 35 fathoms, gray sand bottom, and bottom water temperature was 7.2° C. Results were practically nil. Only 7 baby halibut and four small yellowfin "sole" were caught.

Set No. 24 was made in position Lat. 57° 58.5' N., L. 151° 44.5' W., towing SWxW for 60 minutes at 2 knots. Soundings showed 60 fathoms, hard

6/ Op. cit.

bottom, and bottom water temperature 6.2° C. This drag produced 1 red king salmon, weighing 35 pounds, 220 marketable size codfish, 100 tanner crabs, one scallop, 50 flathead "sole", 20 arrow-toothed flounder, a few small red rockfish, and 5 undersized halibut. The weight of cod taken was estimated at 1100 pounds.

Set No. 25 was made in position Lat. 57° 57' N., L. 151° 53' W., towing northward at a speed of 2 knots for 60 minutes. Soundings showed 63 fathoms, hard bottom, and bottom water temperature, 6.3° C. This drag produced the first king crabs caught by the expedition in the Kodiak area, consisting of 3 large, 1 medium, and 1 small male crabs. Also caught were 100 tanner crabs, 3 scallops (Pecten hindsii), 1000 pounds of fair sized cod, and 100 flathead flounder. Several undersized halibut, small red rockfish, and yellowfin "sole" also were taken.

Set No. 26 was made in position Lat. 57° 49' N., L. 151° 57' W., towing SE at 2 knots for 60 minutes. Soundings indicated 60 fathoms, fine, hard sand bottom, and bottom water temperature, 7.0° C. Results were poor, consisting of 200 mixed yellowfin and flathead "sole", mostly small and thin, a few small arrow-toothed flounder and cod, and about 200 tanner crabs.

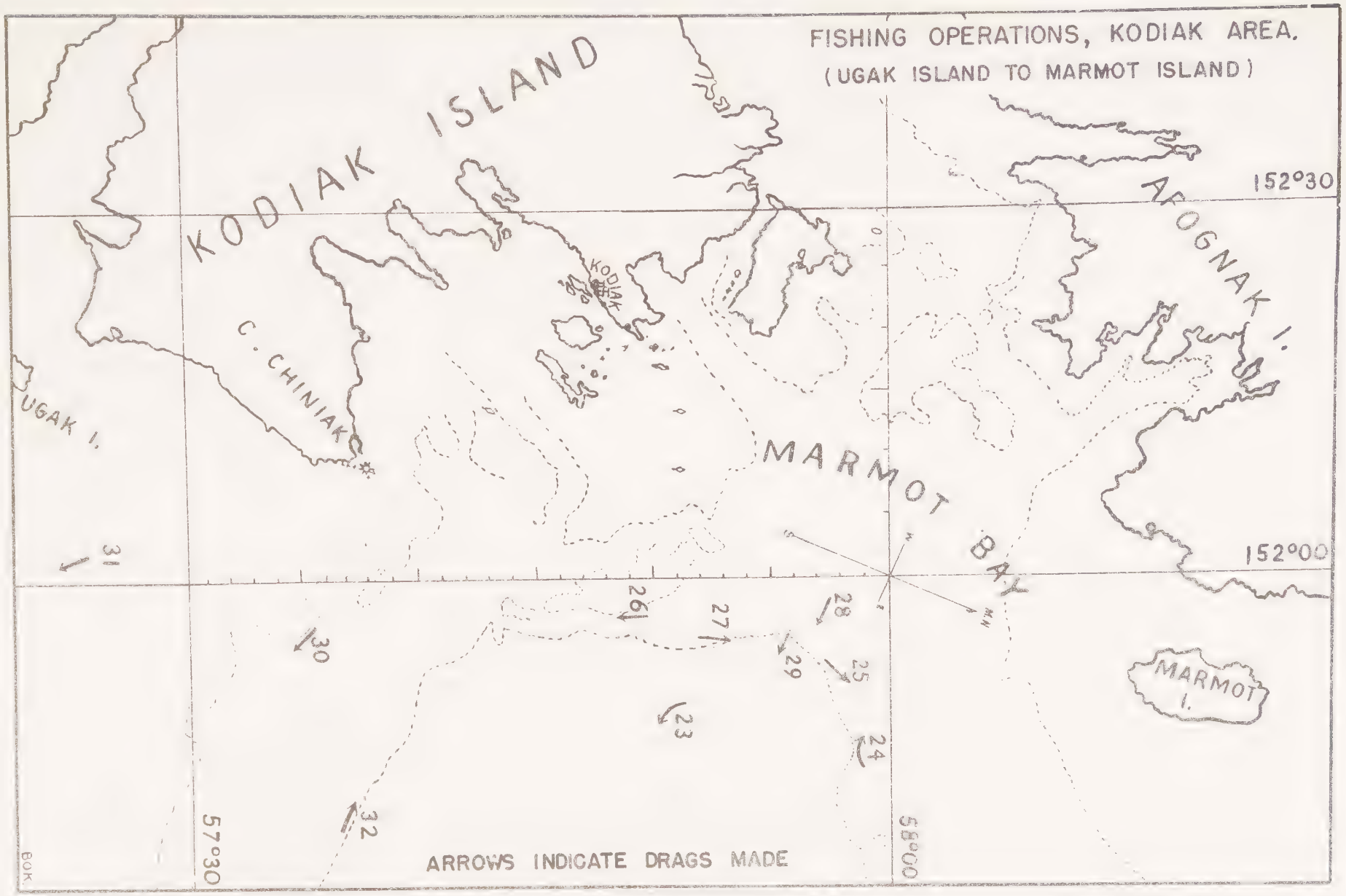
Set No. 27 was made in position Lat. 58° 52', L. 151° 55' W., towing NNW for 60 minutes at a speed of 2 knots. Soundings averaged 50 fathoms, with sand bottom and bottom water temperature of 7.55° C. Caught in this drag were 1 - 15 pound male king crab, 2 king salmon, weighing 8 and 3 pounds respectively, 10 cod, 100 tanner crabs, 200 mixed small flathead and yellowfin "sole", several lemon "sole" and arrow-toothed flounder, and a few scallops, including the common bay scallop (Pecten hindsii) and the giant scallop (Pecten caurinus).

Set No. 28 was made in position Lat. 57° 57.5' N., L. 151° 58' W., towing easterly at a speed of 2 knots for 90 minutes. Soundings indicated 108 fathoms to start, and 44 fathoms at the end; black sand bottom, and bottom water temperature of 5.8° C. The drag caught more than 1000 tanner crabs, and about 2000 flatfish, mostly small flathead and yellowfin. In addition, several sablefish, cod, scallops, 60 small red rockfish, and about 300 arrow-toothed flounder were taken.

Set No. 29 was made in position Lat. 57° 56' N., L. 151° 55' W., towing eastward at a speed of 2 knots for 45 minutes. Soundings showed 40 fathoms, gray sand bottom, and bottom water temperature, 6.8° C. Caught were 10 female king crabs, 1 male king crab, and many tanner crabs. Also taken were a few scallops, baby halibut, and cod. About 350 pounds of mixed flathead and yellowfin "sole" were caught, of which only about 40 pounds were of marketable size and quality.

Set No. 30 was made in position Lat. 57° 35.5' N., L. 151° 56' W., towing ESE at 2 knots for 60 minutes. Soundings showed 60 fathoms, gray sand with black specks and some broken shells; bottom water temperature, 6.45° C.

FIG. 7


FISHING OPERATIONS, KODIAK AREA.
(UGAK ISLAND TO MARMOT ISLAND)
KODIAK ISLAND
KODIAK
C. CHINIAK
UGAK I.
AFOGNAK I.
MARMOT BAY
MARMOT I.
152°30
152°00
57°30
58°00
31
30
26
27
28
29
25
23
24
32
ARROWS INDICATE DRAGS MADE

Results of this drag were poor. Caught were 50 tanner crabs, 50 small cod, 4 small sablefish, several small scallops, 50 mixed flathead and yellowfin "sole" (almost all of marketable size and quality), and numerous sculpin.

Set No. 31 was made in position Lat. 57° 26' N., L. 152° 02' W., towing southeastward at speed of 2 knots for 60 minutes. Soundings indicated 44 fathoms, bottom of pebbles and broken shells, and bottom water temperature of 6.4° C. This drag produced about 400 pounds of mixed flathead and yellowfin "sole", of which about fifty percent were of good marketable quality and size. Also caught were one chum, and one small king salmon, numerous undersized halibut, 42 small cod, one male king crab, several tanner crabs, as well as numerous sculpin.

Set No. 32 was made in position Lat. 57° 36.5' N., L. 151° 39.5' W., towing westward at speed of 2 knots for 60 minutes. Soundings showed 44 fathoms, fine, clean sand bottom, and bottom water temperature of 7.05° C. About 2000 flatfish were caught in this set, consisting of mixed flathead and yellowfin, and about fifteen percent of English "sole". Mostly these were small and thin, except for the English, which were good size and prime quality. Also caught were a halibut weighing 55 pounds, an immature king salmon, and several cod, sculpin, and tanner crabs. This set concluded the investigational fishing work for the 1948 season.

It is felt that sufficient ground was tested in the Kodiak area to justify certain limited conclusions. The bays in the area investigated produced so few flatfish of marketable size or quality that it would not appear that a suitable trawl fishery exists there at this time of year. Also, the areas offshore to the extent investigated did not produce flatfish in suitable quantity or quality to indicate much promise for this fishery in the month investigated. However, it is very likely that these fish have moved to deeper waters during this period, and may be present in suitable quantity and quality at other seasons.

The absence of king crabs from localities where they are known to exist confirms the migratory habits of this species, and this is further indicated by the catching of king crabs in the deeper waters of the Marmot Bay area. Presumably at this time of year the king crabs have left the shallower waters of the bays, and moved into deeper waters.

The scallops caught in the area were commercial species, and considered of fine quality. With the correct type of gear, the possibility exists that this resource could be located in quantity. The numerous shrimp found in several drags were commercial species, and of good quality, indicating the possibility of a shrimp resource near inshore areas. Several tows in the Marmot Bay area resulted in catching king salmon. Although these were only a scattered fish or two, it is not common to take salmon in a trawl net. There is a possibility that trolling in these locations would produce king salmon in satisfactory quantity.

The weather in the Kodiak area, (as in the other areas worked on this trip), is not suitable for sustained fishing effort at the time of year investigated, particularly by smaller vessels. From a negative angle, one of the most

interesting facts was the pronounced scarcity of codfish. The local inhabitants stated that while codfish were formerly very plentiful in the Kodiak area, now they are quite scarce. As far as the exploratory fishing was concerned, their scarcity would seem to have been confirmed. Many theories are advanced by the local people for this decline, but nearly all point out that there seems to be a decided correlation between the marked increase of the sea lion population in the area and the dearth of codfish. In conclusion, enough indications were found of a flatfish resource in this area to warrant the hope that at the right time of year, probably during the summer months, much more satisfactory results might be expected.

Summary of Technological Aspects

The primary purpose of the technological work on the trip was to ascertain the marketability of species of fish available in the area, and to compare the commercial aspects of returning the fish, frozen in the round for filleting ashore, with the normal procedure of filleting the iced fish which have been trawl-caught on nearby banks. Approximately 1,000 pounds of whole flatfish were frozen aboard ship from various drags by selecting the fish 12" or more in length from the 3 commonest species. Additional miscellaneous samples of fish, crabs, shrimp, etc., were frozen, and in some cases preserved in formalin solution for further identification and study ashore. Although all catches were sorted to determine species, average size, and percent of marketable size fish, with no biologist aboard, it was impossible to completely analyze the catches. Complete biological analysis of the varied species of fish and the wealth of bottom life encountered in every drag would furnish valuable information for studies of fish movement, the effects of overpopulation on the banks, and on the feeding habits of food fish.

The five species of flounder represented in the sample for study ashore were rock, yellowfin, flathead, sand, and English flounder. All fish were frozen in the round aboard ship within a half hour after the fish bag was brought aboard. There was no sharp freezer available on the Washington; consequently, the fish were both frozen and stored in the refrigerated hold at 0° F. No fillets were prepared and frozen aboard ship.

After the return of the Washington to Seattle and four weeks after the initial freezing of the fish aboard ship, the entire lot of frozen sole in the round was thawed, filleted, packaged, and refrozen under commercial conditions in a local filleting plant. The fish were thawed slowly in air by stacking loosely on the fishhouse floor until thawed sufficiently to fillet. In most cases the fish were slightly stiff and the flesh next to the backbone was partly frozen when the fish were filleted. The professional filleter employed on the job reported that there was no difficulty in handling the fish compared to locally produced fish except that the fish averaged smaller in size, and for this reason, the yield per unit of labor was somewhat less than that from larger fish. The weight of the individual fish ranged from 0.9 to 1.7 pounds. The yield of skinned fillets on the basis of the whole fish averaged from a low of 28 percent for the smaller flathead sole to a high of 35.6 percent for the larger sand sole. An overall yield of 29 percent was obtained, a figure comparing favorably with that for flatfish from near-by banks.

The fillets were wrapped in MSAT cellophane and packaged [illegible] a 5 pound waxed carton. Freezing was accomplished at -30° F. in a blast freezer and the fillets were stored at 0° F.

Preliminary examination of the fillets at the Seattle laboratory indicated that although the fish were not of the most desirable size and weight for filleting when compared to the larger sole brought in on ice from local banks, the quality, color, firmness and marketability of the fillets ranked definitely above the average of locally produced fillets. The amount of "drip" on thawing individual packages of fillets was determined for each of the five species two weeks after refreezing. The overall average was 5.5 percent "drip" with a range from 4.7 percent to 9.3 percent. This compared favorably with an average of 6.2 percent "drip" for a small sample of frozen fillets purchased on the open market and an average of 9.5 percent drip for refrozen sole fillets in previous studies. It is thought that the explanation for the smaller losses of "drip" on thawing this experimental lot of fillets lies in the fact that the fish were frozen in the round while absolutely fresh. The fish were frozen before rigor mortis set in, as was shown by the fact that rigor was noticed in some of the whole fish after they were thawed for filleting.

To supplement the judgment of laboratory personnel on the quality of these fillets, an effort was made to obtain opinions from critical buyers on the local waterfront by circulating samples of the refrozen fillets. No previous information on the method of preparation was given to the individuals who agreed to examine and test the fish. A form for comments and ratings of the quality was circulated with the samples. The comments and ratings received from personnel of 10 local fishery firms has indicated that, with the exception of two individual ratings for flavor and texture, all judges have rated the refrozen fillets superior to local fillets in regard to color, flavor and texture. Unsolicited comments were received personally which emphasized the excellent color and texture of the fillets. The enthusiastic response has demonstrated to a considerable degree that excellent fillets can be produced by refreezing fillets prepared from fish frozen absolutely fresh.

The samples of immersion brine frozen salmon and flatfish which were returned to the laboratory were tested in connection with preliminary recommendations to the industry for utilization of brine-refrigerated boats in the Alaskan area. These samples were frozen aboard ship by immersion in strong brine held at 6° F. Samples were stored in the brine at this temperature for 3 weeks aboard ship and then transferred to the laboratory cold storage room maintained at 0° F. It was found that the brine-frozen fish were suitable for thawing and immediate consumption, for thawing and refreezing of edible portion, or, in the case of salmon, for thawing and canning by the usual process.

Inasmuch as the Korean crab was common in certain locations fished by the Washington and also has been reported to be found in considerable concentration in certain areas fished by other vessels near the Peninsula, it was of interest to compare its palatability with king crab. Samples prepared aboard the vessel and at the laboratory were judged entirely edible and wholesome; however, the much sweeter flavor and very soft texture in comparison

with king crabmeat was considered rather undesirable. Although the yield of 35 percent edible meat from the samples tested compares favorably with the yield from king crab, an increased difficulty of recovery would have to be considered.

In conclusion, it can be said that the technological information gained from the trip has demonstrated additional possibilities for further utilization of the fish and shellfish from the area under investigation.

Table 1 - List of Species of Fish and Shellfish Enumerated in Report

Common Names	Scientific Name
Flounder Family:	
Flathead "sole", flathead flounder	Hippoglossoides elassodon
Yellowfin "sole", yellowfin flounder, mud dab	Limanda aspera
Lemon "sole", lemon flounder, Alaska plaice	Pleuronectes quadrituberculatus
Sand "sole", sand flounder	Psettichthys melanostictus
Rock "sole", rock flounder	Lepidopsetta bilineata
Dover "sole", slime flounder, slippery flounder	Microstomus pacificus
English "sole", lemon "sole", lemon flounder	Parophrys vetulus
Starry flounder	Platichthys stellatus
Arrow-toothed flounder, arrow-toothed halibut, turbot	Atheresthes stomias
Halibut	Hippoglossus stenolepis
Miscellaneous Fish	
Cod, Pacific cod	Gadus macrocephalus
Tomcod	Microgadus proximus
Pollock, whiting, Alaska pollock, wall-eyed pollock	Theragra chalcogramma
Sablefish, black cod	Anoplopoma fimbria
Greenling, common	Hexagrammos stelleri
Red Rockfish	Sebastodes species
Salmon, King	Oncorhynchus tshawytscha
Salmon, chum	Oncorhynchus keta
Smelt, capelin	Mallotus catervarius
Smelt, Eulachon	Thaleichthys pacificus
Herring	Clupea pallasii
Sculpin, Irish Lord	Hemilepidotus sp.
Shellfish	
Pink shrimp	Pandalus borealis
Coon-stripe shrimp, red shrimp	Pandalus hypsinotus
Gray shrimp 1/	unknown species
King crab	Paralithodes camtschatica
King crab (purple species) 2/	Paralithodes platypus
Tanner crab	Chionoecetes bairdii
Dungeness crab	Cancer magister
Korean crab, horse crab	Erimacrus isenbeckii
Scallop, small, bay scallop	Pecten hindsii
Scallop, giant	Chlamys caurinus

Note: For the purpose of the present report, no identifications have been included for many of the small fish, shells, bottom life, and growths found in the catches.

1/ Many samples of gray shrimp were obtained in drags in the Nome-St. Lawrence Island area, but were later lost with other samples during heavy weather.

2/ All the king crab caught in the area near Nome-St. Lawrence Island were of this species.

FIG. 8 - U.S. FWS WASHINGTON AT ANCHOR IN THE NOME ROADSTEAD, BERING SEA.

FIG. 9 - THE LARGE TRAWLING WINCH MOUNTED AMIDSHIPS. TOWING WIRE IS BEING LET OUT AS THE NET IS LOWERED TO THE BOTTOM IN THE BERING SEA.

FIG. 10 - HAULING THE OTTER DOORS AFTER THE NET HAS BEEN BROUGHT TO THE SURFACE. AFTER THE DOORS ARE FASTENED TO THE STANCHIONS, THE GEAR IS SWUNG TO THE VESSEL'S STARBOARDSIDE.

FIG. 11 - THE ELECTRIC BOOM WINCH IS USED TO PICK UP THE CABLE FROM THE NET WHILE THE VESSEL IS SWUNG TO THE STARBOARD.

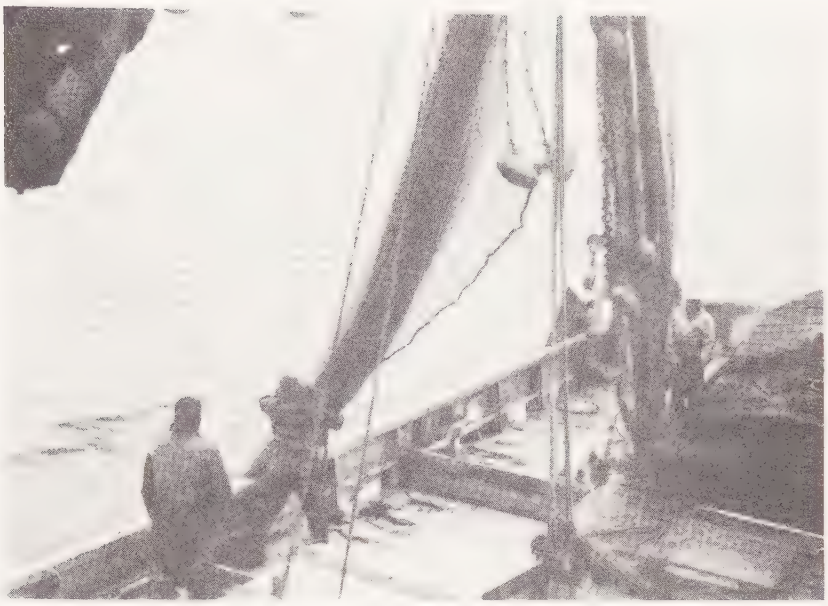


FIG. 12 - HOISTING THE NET ABOARD. A STRAP AT THE RAIL IS USED TO HOLD THE NET WHILE THE WINCH IS SLACKED OFF TO PERMIT STACKING THE NET ON THE STERN.

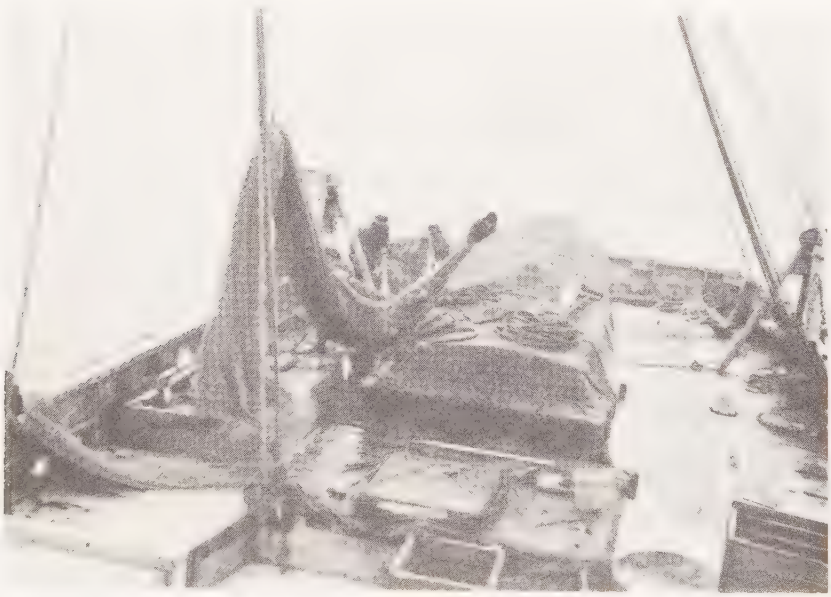


FIG. 13 - STACKING THE NET. AS THE NET IS BROUGHT ABOARD, IT IS STRAIGHTENED AND STACKED ON THE STERN READY FOR THE NEXT STEP.

FIG. 14 - THE COD END WITH A LOAD OF BOTTOM FISH IS HOISTED ABOARD. HEAVY SWELLS TAKEN OCCASIONALLY OVER THE RAIL MAKE THE WORK DIFFICULT.

FIG. 15 - DUMPING THE CATCH. THE LINE ON THE COD END IS LOOSENED TO FREE THE CATCH. (NOTE THE HEAVY CHAFING GEAR USED TO PROTECT THE COD END WHEN ON THE BOTTOM.)

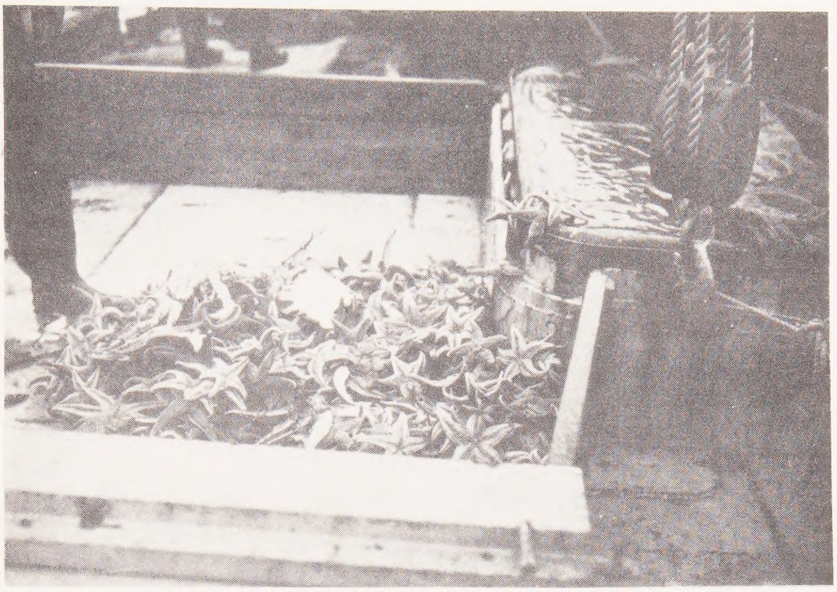


FIG. 16 - A CATCH FROM NORTON SOUND (DRAG NO. 4) MOSTLY STARFISH, SMALL FISH AND BOTTOM LIFE, A FEW KING CRABS, AND A FEW FLATFISH WERE IN THIS CATCH.

FIG. 17 - A FEMALE KING CRAB (P. PLATYPUS) FROM NORTON SOUND AREA (DRAG NO. 4). SPECIMENS OF THIS SPECIES WERE MUCH SMALLER THAN THE SPECIES (P. CAMSCHATICA) WHICH IS FOUND IN MORE SOUTHERLY AREAS.

FIG. 18 - PART OF A CATCH FROM THE BERING SEA (DRAG NO. 9). A FAIR-SIZED COD, ARROW-TOOTHED FLOUNDER, SKATES, SMALL POLLOCK, AND TANNER CRABS ARE SHOWN. ROUGH WEATHER MADE IT DIFFICULT TO SORT THIS CATCH.

FIG. 19 - MENDING THE NET WHILE ANCHORED OFF NOME IN THE BERING SEA.

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